REMARKS

Entry of the amendments to the specification and claims, as amended by way of Annexes to the International Preliminary Examination Report for PCT/EP2004/008239, before examination of the application in the U.S. National Phase is respectfully requested.

If there are any questions regarding this Preliminary Amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket # 095309.57311US).

Respectfully submitted,

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ABSTRACT OF THE DISCLOSURE

~~The invention relates to~~ In a method for operating a drive system for a motor vehicle comprising an internal combustion engine [[(1)]] and an electric machine, ~~(6), it being possible to accelerate a driveshaft (4) of the internal combustion engine by means of the electric machine (6), and~~ in the event of an upshift and/or when an upshift is initiated, [[an]] the electric machine increases the idling rotational speed of the driveshaft. ~~(4) is increased by the electric machine (6).~~ If a turbocharger is used to increase the charge pressure of the internal combustion engine, an increase in the idling rotational speed by the electric machine ~~can compensate~~ compensates for low efficiency of the turbocharger at low rotational speeds.

~~(Fig. 2)~~

Marked Up Substitute Specification
Attorney Docket No. 095309.57311US

Method for operating ~~operation of~~ a drive system

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] This application claims the priority of German patent document 103 35 259.7, filed August 1, 2003 (PCT International Application No. PCT/EP2004/008239, filed July 23, 2004), the disclosure of which is expressly incorporated by reference herein.

[0002] The invention relates to a method for operating a drive system for a vehicle ~~comprising~~ having both an internal combustion engine and an electric machine, it being possible to accelerate a driveshaft of the internal combustion engine by means of the electric machine.

[0003] A starter/generator for an internal combustion engine of a motor vehicle~~, which is known from the~~ disclosed in European patent document EP 0 876 554 B1[[,]] comprises an electric three phase machine which performs both starter and generator functions. In addition, the electric machine can be used to achieve ~~effect~~ or assist an acceleration and/or braking of the driveshaft, ~~particularly~~ in order to accelerate or brake [[a]] the vehicle and/or ~~in order~~ to prevent slipping of a driven wheel in ~~the context of~~ an anti-slip control, by braking the internal combustion engine or at least one driven wheel. The electric machine can also be used to reduce rotational ~~non uniformities~~

irregularities of the driveshaft by virtue of the fact that for compensation purposes, it generates a rapidly alternating opposite phase torque.

[0004] In ~~the case of~~ low volume internal combustion engines ~~in the field of~~ designed for automobiles, the reduction in torque which results from the reduced stroke volume is often compensated [[for]] by means of pressure charging, for example ~~particularly~~ by ~~means of~~ an exhaust gas turbocharger. In the case of an exhaust gas turbocharger, the turbine rotates more quickly as the exhaust gas flow increases, which increases ~~. This results in an increase in~~ the charge pressure, (that is, ~~to say~~ the pressure with which the air is forced into the combustion space of the internal combustion engine). The effect of the exhaust gas turbocharger is, however, restricted at low engine speeds and in part-load situations because of the wide span of exhaust gas and the low speed of the exhaust gas flow. This results in poor starting performance of such internal combustion engines of low stroke capacity ~~in particular~~ (so-called "turbo lag"). The use of variable turbine geometry is difficult to implement in the case of a spark ignition engine with its high exhaust gas temperatures and geometric combustion, and ~~results in~~ achieves only an insignificant increase in the starting torque. Solutions having electrically assisted pressure charging systems or electrically assisted exhaust gas turbochargers are technically highly complex.

[0005] Considerable dead times occur, particularly in conjunction with ~~automated~~ automatic clutch systems, because of the low efficiency of the exhaust gas turbocharger at low rotational speed (when the vehicle starts and during shifts until the clutch can engage). In this context it is assumed that, as is

generally customary, a control unit~~, particularly~~ (such as an engine and/or transmission control unit) ~~, is provided which~~ monitors the engine speed and allows complete engagement of the clutch only when ~~the rotational speed~~ it has exceeded a certain limit value. [[and in]] (In this [[way]] manner, so-called "stalling" of the internal combustion engine after the clutch has engaged cannot occur.) In order to prevent the internal combustion engine from stalling, the clutch is typically operated in a slipping manner until the internal combustion engine speed has reached a sufficiently high [[value]] speed.

[0006] ~~It is an~~ One object of the invention is to provide a method for operating a drive system for a motor vehicle which ~~leads to~~ achieves short clutch engagement times, particularly in the low rotational speed range.

[0007] This and other objects and advantages are achieved by the ~~The object is achieved by means of a method having the features of claim 1. The~~ method according to the invention, ~~is characterized~~ in which ~~that when an upshift is initiated or in the event of an upshift, an~~ the idling rotational speed of the driveshaft is increased by the electric machine when an upshift is initiated or in the event of an upshift.

[0008] A starter/generator or motor/generator which is already provided in the motor vehicle and can be used in particular for stop/start operation is preferably used as the electric machine. The electric machine can drive the driveshaft by means of a belt provided for this purpose. It can however also be arranged directly on the driveshaft (a so-called integrated arrangement). An

electric three phase machine, ~~particularly~~ such as a synchronous machine, an asynchronous machine or a reluctance machine, is preferably used.

[0009] The invention permits the vehicle [[A]] clutch [[can]] to be engaged earlier, without the internal combustion engine "stalling", due to the ~~assisting acceleration of~~ assistance provided by the electric machine for accelerating the driveshaft ~~by means of the electric machine~~, since the driveshaft rotational speed more quickly exceeds the [[limit]] minimum driveshaft rotational speed[[,]] (described ~~in the introduction~~ hereinabove), for engaging the clutch, ~~earlier~~ thanks to the additional acceleration. A control unit therefore needs to [[keep]] maintain the clutch ~~operating~~ in a slipping ~~manner~~ state for less time than in the case of operation without an increase in idling rotational speed by the electric machine. Engagement of the clutch can be permitted correspondingly earlier.

[0010] Clutch engagement times when starting and during shifts can therefore be advantageously shortened both with manually operated and with ~~automated~~ automatic clutch systems and shift systems. Faster and more comfortable starting and shifting behaviour can be obtained as a result.

[0011] The method according to the invention can advantageously be used to compensate for the so-called "turbo lag", described ~~in the introduction~~ previously, which is caused by the low efficiency of an exhaust gas turbocharging system at low rotational speeds. The method according to the invention can however also be used at relatively high rotational speeds.

[0012] Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

~~Further advantageous embodiments of the invention are disclosed in the subclaims and the exemplary embodiments which are described in the following on the basis of the drawing, in which:~~

[0013] Fig. 1 is [[shows]] a schematic illustration ~~(not to scale)~~ of a drive system; and

[0014] Fig. 2 is a ~~shows an exemplary~~ graphic illustration of representative temporal characteristics of vehicle-related variables ~~with respect to time~~ which result with and without acceleration assistance from the electric machine.

DETAILED DESCRIPTION OF THE DRAWINGS

[0015] Figure 1 shows a drive system for a motor vehicle which comprises an internal combustion engine 1 and an electric machine 6. A driveshaft or crankshaft 4 is assigned to the internal combustion engine 1 and can be connected to a transmission shaft 5 of a transmission 2 by means of a clutch 3. The electric machine 6 is preferably arranged on an engine housing, which is not indicated in more detail, and can drive the driveshaft 4 of the internal combustion engine 1 by means of a belt 7. ~~The electric machine 6 can thus~~ Thus,

in addition to the internal combustion engine 1, the electric machine 6 can set the driveshaft 4 in rotation and accelerate and/or brake the latter. The electric machine 6 is preferably supplied with electrical energy and controlled by a power electronic unit (not illustrated), and comprises a power converter or power inverter, and a control unit ~~which is~~ (not ~~illustrated~~ shown). The control unit [[can]] may be a separate ~~control unit. The control unit can however~~ component, or it may also be integrated in a drive system control unit which is already present[[,]] (for example an engine control unit and/or a transmission control unit).

[0016] If the clutch 3 is disengaged for a shift, it is preferably not engaged again until the (idling) rotational speed of the driveshaft 4 has reached a sufficient value, so that after the clutch 3 has engaged, the driveshaft 4 is not braked to a value at which the internal combustion engine could "stall". A further control unit (not ~~illustrated~~ shown) therefore usually ensures that the clutch 3 is operated in a slipping manner until the rotational speed of the driveshaft 4 has reached a sufficiently high value at which the internal combustion engine cannot "stall" after the clutch 3 has engaged. This further control unit can be either a separate ~~control unit. The further control unit can however also be~~ component, or integrated in a drive system control unit which is already present[[,]] (for example an engine control unit, ~~and/or~~ a transmission control unit, and/or a control unit for controlling the electric machine).

[0017] In the method according to the invention, when an upshift is initiated or in the event of an upshift, the electric machine 6 increases the idling

rotational speed of the driveshaft 4 ~~is increased by means of the electric machine 6 when an upshift is initiated or in the event of an upshift~~ to a value which prevents the internal combustion engine 1 from "stalling" when the clutch 3 is engaged. ~~By means of the method according to the invention,~~ Such an increase of the idling rotational speed can compensate for the ~~can be increased and thus a~~ low efficiency of the turbocharger at low rotational speeds. This is ~~can be compensated for~~ particularly so when an exhaust gas turbocharger ~~(not illustrated), which~~ that has [[a]] low efficiency at low rotational speeds (and [[which]] can thus contribute only ~~contribute~~ a small amount to the increase in rotational speed/torque in this rotational speed range)[[,]] is used to increase the charge pressure.

[0018] By way of example, figure 2 shows characteristic curves of the driveshaft rotational speed and [[of a]] vehicle speed ~~with respect to~~ as a function of time, ~~as they occur~~ with and without acceleration assistance from the electric machine. ~~The time~~ (Time is plotted on the abscissa.) The rotational speed is plotted on the left ordinate and the vehicle speed is plotted on the right ordinate. The characteristic curves f_1 and f_2 ~~are characteristic curves of the~~ show rotational speed[[,]]; the rotational speed characteristic f_1 [[being]] is produced with acceleration assistance from the electric machine and the rotational speed characteristic f_2 [[being]] is produced without acceleration assistance from the electric machine.

[0019] The characteristic curves f_3 and f_4 ~~are characteristic curves of the~~ vehicle speed~~, the vehicle speed~~. The characteristic f_3 [[being]] is produced with

acceleration assistance from the electric machine, and the ~~vehicle speed~~ characteristic f_4 [[being]] is produced without acceleration assistance from the electric machine. The brake pedal is released at 0 seconds, and full [[. Full]] throttle is applied at the time t_1. If an electric machine is used for drive assistance, this electrical assistance comes into effect from the time t_1 onwards.

[0020] Up to the time t_1, the rotational speed characteristics f_1 and f_2 have similar, nearly constant behaviour. However, while the rotational speed characteristic f_1 effected with the use of drive assistance from the electric machine already rises at the time t_1, the rise in the rotational speed characteristic f_2 does not occur until approximately 0.08 seconds later.

[0021] The motor vehicle with drive assistance from the electric machine correspondingly starts at the time t_2 (see vehicle speed characteristic f_3), while the motor vehicle without drive assistance from the electric machine does not start until a time t_3 (see vehicle speed characteristic f_3), t_2 being smaller than t_3. According to the vehicle speed characteristics f_3 and f_4, the motor vehicle with drive assistance from the electric machine reaches a higher speed at an earlier point in time than the vehicle without drive assistance from the electric machine.

[0022] The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.